THE OCCURRENCE OF COAL AND MICA IN PLEISTOCENE DEPOSITS NEAR CINCINNATI.

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INTRODUCTION.

The occurrence of coal and mica in Pleistocene deposits has not been reported in southwestern Ohio. It may have some interest for two reasons. Because there is neither coal nor mica in southwestern Ohio, their occurrence in a deposit of transported material raises the question of their source of supply. In addition, the location of the deposit is such as to shed light on a problem of pre-glacial drainage.

LOCATION AND DESCRIPTION OF DEPOSIT.

One mile east of the point where the Little Miami river joins the Ohio river (Fig. 1, a) is a bluff cut into a deposit of fine sand covered with bowlder clay. The Miami river flows at this point southeastward in the abandoned valley of the pre-glacial Ohio, which flowed in the opposite direction. The old valley continues along the Miami, reversed in direction, about four miles and then curves northwestward through Norwood, northward through Lockland, and thence toward Hamilton, Ohio. (Fig. 1, b).

In 1929, this bluff was excavated for road-building purposes, and in such a fresh exposure the precise nature of the material was revealed.

The top of the exposure is about 615′ A. T., the base about 500′ A. T., a little above the flood plain of the river, which is here about 480′ A. T. Everything in the bluff below 575′ A. T. is sand, grading toward the top into very fine grains and very regularly laminated beds. (Fig. 2.) The upper half of the sand shows horizontal beds an inch or less apart with fine cross-bedding planes between, caused by gentle current action. (Fig. 3.)

At about 535′ A. T., the sand is cemented in place, perhaps due to the later spread of Wisconsin outwash waters through

the sand already then flanking the valley. At least the level corresponds with that of the Wisconsin water-laid terrace at Cincinnati.

Above 575′ A. T. the deposit is capped with bowlder clay, separated from the sand below by a band of limonitic cement with 10 to 12 inches of fine, laminated clay above it.

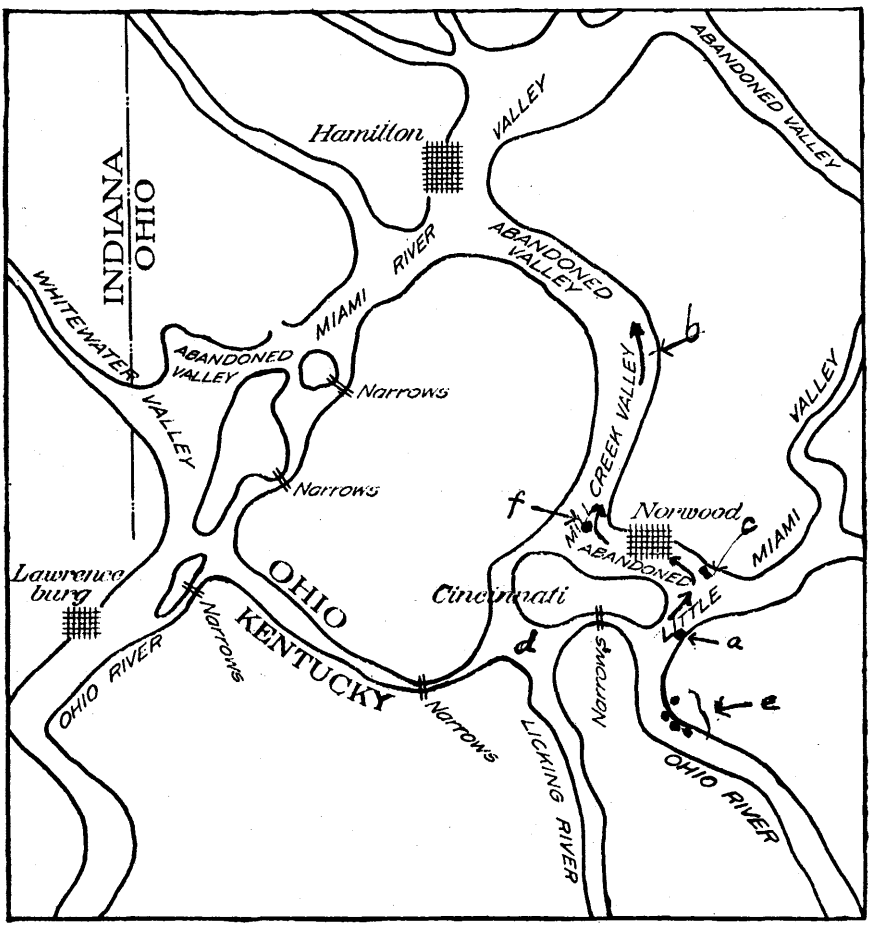

FIGURE 1. Sketch map of valleys in the vicinity of Cincinnati. (After Fenneman.)

a. Deposit with abundance of coal and mica.
b. Pre-Illinoian valley of the Ohio.
c. Gravel at surface in Illinoian valley fill.
d. Cincinnati basin.
e. Glacial outwash capped with bowlder clay.
f. Coal and mica in "Norwood trough."

An interesting fold in the beds of sand, quite distinct from the cross-bedding and on a much larger scale was exposed in 1929. (Fig. 4.) Mention of it might be omitted from the description, because it has no apparent bearing on the origin of the deposit nor on the history of the drainage. However, it was an unusual feature, perhaps worthy of mention.

The fold was about two yards long and two feet high and was cut by the excavation in longitudinal section which was at approximately a right angle to the direction of the valley. The pressure must have been due to ice shove at a time when the water at this level was frozen over. The bedding planes were perfectly preserved across the fold. This may have been due to slight cementation of lime, in case a water level had been maintained for a more or less prolonged period, or, more probably to the cementation of ice at the time of folding.

ILLINOIAN TERRACE AT CINCINNATI.

The unconsolidated material of the deposit near the Miami has been considered a part of the glacial terrace of Illinoian age, represented by remnants in most pre-glacial valleys in the immediate vicinity of Cincinnati. This Illinoian valley fill is chiefly outwash, being built up of water-laid material, often gravelly, to the level of 575′ to 590′ A. T. and capped with bowlder clay to the level of 600′ to 625′ A. T., the latter deposited as the ice overrode its own outwash.

Exceptions to this rule are to be noted where, in restricted areas in the normal valley fill, there are exposures showing gravel at the top instead of bowlder clay. Such an exception occurs in part of Madisonville and part of the new town of Mariemont on the eastern side of the "Norwood trough," the abandoned valley of the ancestral Ohio. (Fig. 1, c). This gravel is at the top at the same level and side by side with the normal bowlder clay capping and may be interpreted to mark the course of a small stream on the ice.

There are also exceptions to the general condition of outwash and no bowlder clay in the lower part. In several exposures some bowlder clay appears in the outwash, but the many exposures in which the lower part is all outwash material would seem to rule out the possibility of any general advance of the ice earlier than the last event of Illinoian time. The cases in which bowlder clay appears in the lower outwash may be attributed, perhaps, to blocks of ice or even tongues of ice advancing part way down the valleys.

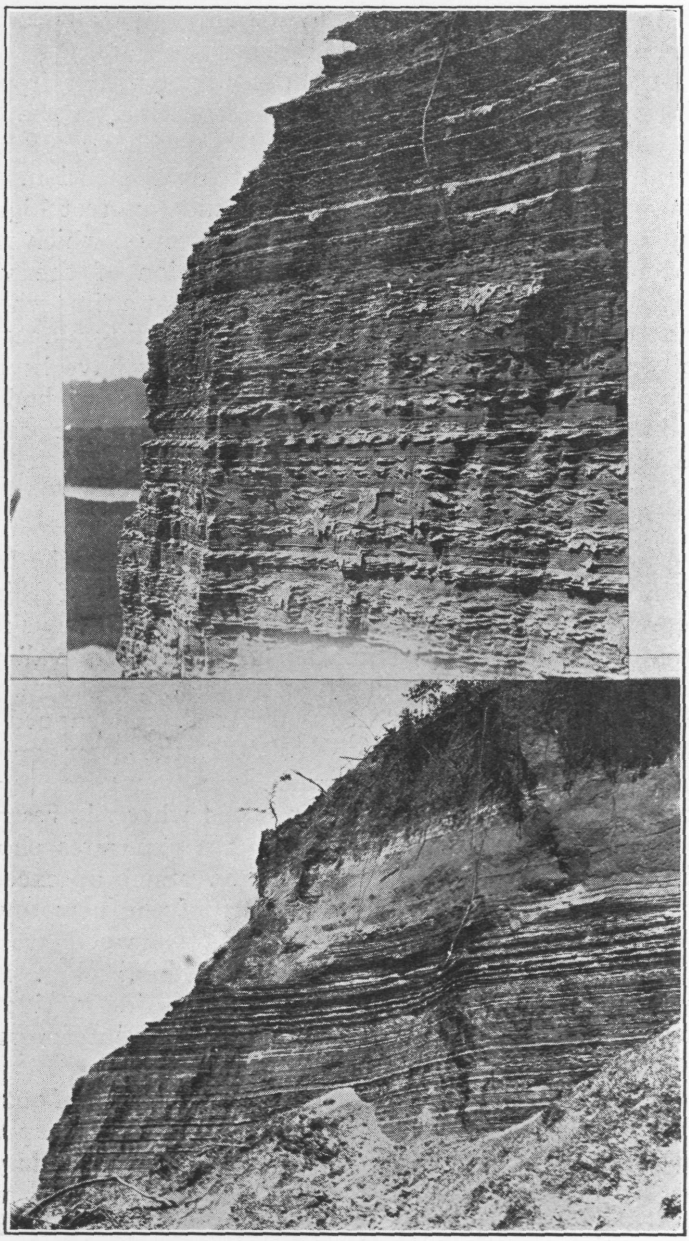

FIGURE 2. (Lower.) Deposit of fine sand interbedded with coal and mica, and covered with bowlder clay.

FIGURE 3. (Upper.) Finely laminated sand showing cross-bedding.

In the main, the Illinoian valley deposits at Cincinnati record a predominant outwash condition followed by a final, general advance of the ice. This is a statement of field observation. If it were not true, it would be a difficult matter to explain the existence of a practically level and concordant terrace of Illinoian age, abutting sharply against the valley walls which rise 200-250 feet higher. This can be seen in dozens of instances near Cincinnati.

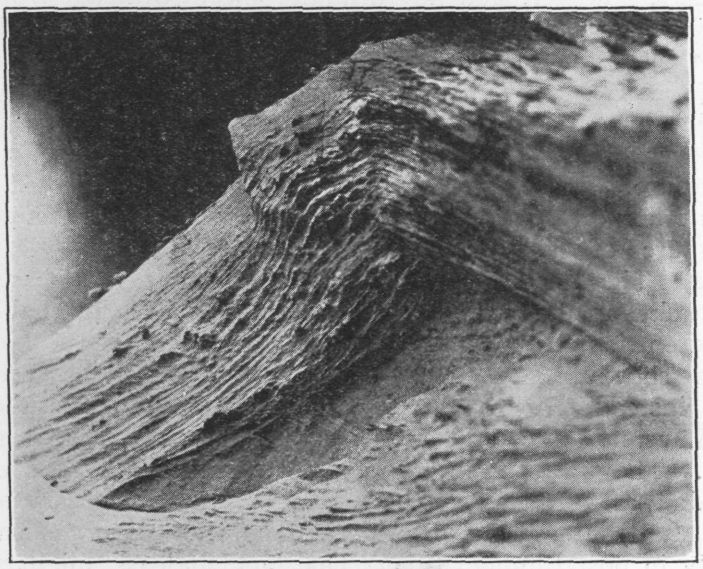

FIGURE 4. Fold in laminated sand.

OCCURRENCE OF COAL AND MICA.

It is in the fine sand between the cemented zone at 535′ A. T. and the limonite cement at 575′ A. T. that coal and mica occur abundantly. Nearly all the bedding planes are lined with black and some bands as wide as two inches are more coal than anything else. Also interbedded with the coal is an abundance of small mica flakes. This necessitates a common source of supply for both mica and coal. Rounded coal pebbles, usually small, but up to three inches in diameter are plentiful. These are very fragile and crumble in one's fingers when they are removed from the deposit where they lie imbedded. It seems doubtful whether any identification would be possible.

PROBLEM OF ORIGIN.

We have to do clearly with outwash from a coal field somewhere. It is also clear that coal is too fragile a sediment to be transported far in the form of pebbles. However, there are no coal beds in southwestern Ohio and no mica.

The nearest coal fields and the possible sources for such a supply seem to be three:

(1) There is coal in the syncline of Michigan. It is most unlikely, however, that any drainage except drainage from the melting ice ever could have found its way from Michigan into the Ohio river valley. It might possibly have been carried in the ice from Michigan and washed by the water in front of the ice into this valley deposit where it is now to be seen. However, this would be a long and devious journey for coal to endure. It seems probable, therefore, that we must look in another direction than that from which the ice came for the source of this Pleistocene deposit.

(2) The Licking river rises in the coal fields of eastern Kentucky and the sandstones associated with the coal beds are often rich in mica flakes. If the headwaters of the Licking can be shown to have discharged along the line of the ancestral Ohio instead of through the Cincinnati basin, as stated by Dr. Leverett,[1] it could have brought the coal, as well as the mica. The wash of its current, however, is badly needed to explain part of the water-cut rim of the Cincinnati basin, (Fig. 1, d) unless we wish to assume that this was carved chiefly in post-Illinoian time. One fact, at least, might serve to support such a view—that there are no remnants of Illinoian terrace anywhere in the basin.

However, if the Licking brought the coal and mica into the old northward curve of the ancestral Ohio, no drainage pattern has yet been traced which would make it possible.

(3) The most plausible origin for the coal and mica deposited near the mouth of the Little Miami seems to be the coal fields of southeastern Ohio, though the distance is greater than one would wish. It might have been carried westward by the Ohio at a time before the old valley trending northward through Madisonville and Norwood had been abandoned. The sand below the bowlder clay would thus be an old Ohio river deposit, not outwash from the ice at all.

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[1]Leverett, Frank. Monograph XLI, U. S. Geol. Sur.

Whatever drainage brought the coal must have continued until the final advance of the Illinoian ice, because the coal and mica continue upward in the deposit almost to the level of the bowlder clay on top. Just above the sand, as stated earlier, are finely laminated beds of clay and these are followed by bowlder clay. As the ice advanced down the old valley from the north, it must have dammed the northward flowing river, causing the deposition of lake beds during a time of temporary ponding. This was followed by the actual advance of the ice which changed the course of the stream to its present east-west direction.

TIME OF BREAKING OF THE DIVIDE AT MANCHESTER, OHIO.

Dr. Leverett says[2] that certain topographic features, chiefly gradation plains and relative widths of valleys, indicate that the divide at Manchester, Ohio was broken at the time of a pre-Illinoian glaciation, while the northward curve of the Ohio at Cincinnati probably continued until Illinoian time. If the laminated sand of this deposit is to be interpreted as a river-laid deposit, built up higher and higher as the advancing ice dammed the northward flowing stream, it is certain, as stated above, that such a drainage continued until the final advance of the ice in Illinoian time. If the coal and mica were transported by the Ohio from the east and not by the Licking from the southeast, it is certain that the Manchester divide had been broken before this deposit accumulated. There is neither coal nor mica west of Manchester.

Hence this one exposure, if it be interpreted correctly, proves definitely that the Manchester divide was broken earlier than the drainage changes were effected at Cincinnati and that the drainage changes at Cincinnati were not brought about until the final advance of the Illinoian ice.

It would also definitely date the breaking of the divide at Manchester as pre-Illinoian, in accordance with Dr. Leverett's evidence, except for one circumstance. This presents an alternative. There is no coal in the lower part of the deposit. It is not impossible that the divide was broken in early Illinoian time and that the old course of the Ohio at Cincinnati was maintained until the last event of the Illinoian. However,

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[2]Leverett, Frank. "Pleistocene of Northern Kentucky." Ky. Geol. Sur., Series VI, Vol. 31, 1929.

as Dr. Leverett points out, an enlarged Ohio must have cut the very wide Norwood trough (1½ to 2 miles) and not a little stream heading seventy miles to the east which has left old loops not wider than one-fourth to one-third mile. Such a large stream, at work during the long inter-glacial time preceding the Illinoian, could more reasonably be credited with completing the wide and deep (365′ A. T.) valley, and into such a valley it could have carried the coal and mica as its current was slackened by the approach of the ice. The coal and mica constitute a near-proof, if not a proof, of this bit of chronology.

OTHER PLEISTOCENE DEPOSITS IN THE VALLEY OF THE PRESENT OHIO.

Two miles south of the terrace described above and within a distance of two miles eastward along the north side of the present Ohio river, (Fig. 1, e) there are four good exposures of glacial material showing cross sections of 100 feet or more. Though these are so near, though they lie in the same valley which was used presumably by the ancestral Ohio, and though they are of about the same level, with water-laid material below and bowlder clay on top, they are obviously very different in origin. The outwash material forming the lower two-thirds or thereabout is largely heavy gravel and sand with coarse cross-bedding, and carrying an abundance of granite, diorite, and other Canadian pebbles. There is no coal or mica.

It is hardly possible that the same stream could have deposited at the same level, at the same time, coarse, cross-bedded gravel at one place and the finest laminated sand not more than two miles farther along its course. Besides, there seem to be no Canadian pebbles in the sand near the Miami. Clearly the two deposits are not parts of the same unit, though the valley is continuous and is thought to have been used in pre-Illinoian time by the same stream.

Some satisfactory explanation must be found. If the deposit near the Miami is in large part a terrace built by the ancestral Ohio river and the concordant terrace exposures along the present Ohio are composed largely of glacial outwash, the latter must have replaced the former in that part of the valley occupied at present by the Ohio river. As the ice advanced, covering the river-laid deposit with bowlder clay, there came a time when the ponded water spilled over the

divide to the west and established the present east-west course of the Ohio river past Cincinnati. This would have furnished a straightened course for the major stream and a natural outlet for the immense volume of ponded water. The heaviest outwash would have been carried into the major valley and the quickened velocity of the water would have carried out the finer sand, which had accumulated in earlier Illinoian time, and would have substituted the glacial outwash for the river-laid sand.

This would seem to the writer a satisfactory explanation of the anomalous data. It is supported by this further fact, that coal and mica are found interbedded with a similar fine sand exposed at Ivorydale near Winton Place, which lies in the northward continuation of the abandoned valley of the ancestral Ohio. (Fig. 1, f.) In the Ivorydale sand there is less of coal and mica, but the fineness of the material and the regularity of the bedding are very similar to that exposed near the Little Miami. The deposits are apparently bits of the same terrace with the same origin.

CONCLUSION.

The occurrence of an abundance of coal and mica interbedded with fine sand in the abandoned northward curve of the ancestral Ohio demands a source of supply for such foreign materials. The most plausible place from which they could have been derived seems to be the coal fields of southeastern Ohio. If this be the origin of the material, and the pre-Illinoian Ohio river be the agent of its deposition, the filling of the abandoned "Norwood trough" is here, at least, largely a river terrace of Pleistocene age rather than a deposit of material derived from the glacier.

If the ancestral Ohio brought the coal and mica, it must have had its source at that time east of Manchester, Ohio, because there is neither coal nor mica west of Manchester. The divide at Manchester must, therefore, have been broken before this terrace of Illinoian age was built, and it must have been in the building until the final advance of Illinoian ice.